INDOOR AIR QUALITY ASSESSMENT

Berkley Community School
59 South Main Street
Berkley, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of a parent, an indoor air quality assessment was done at the Berkley Community School (BCS) in Berkley, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

On January 9, 2002, a visit was made to this school by Cory Holmes, Environmental Analyst for the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Tony Rose, Director of Buildings and Grounds, during the assessment. Also present for portions of the assessment were Robert James, Superintendent of Berkley Public Schools, Sherry Medeiros, School Principal and David DeQuattro and Steven Hughes of The Robinson Green Beretta Corporation, the school's architectural consultant.

The BCS is a two-story brick building originally built in 1962. The existing building was completely renovated and an addition was built in 1989 (see Cover Photo). Two modular classroom wings were added in 1996 and 1998 (see Picture 1). The 1996 modular classroom wing is freestanding. The 1998 modular classrooms are connected to the northeast side of the building via a corridor and are reportedly scheduled to be removed over the next six months. Use of the 1996 modular classroom wing by students will be discontinued at the start of the next academic school year. These modulars will reportedly be rented by senior citizen programs and town offices. In addition, the Berkley School Department (BSD) has reportedly been allotted two-million dollars to conduct renovations, which will include roof work and interior renovation of six rooms of the 1962 wing.

The BCS formerly housed grades preschool through eight, which lead to complaints of overcrowding. However, with the opening of the Berkley Middle School, the BCS now contains preschool through forth grade reducing the school population by approximately half. At the time of the BEHA assessment, fifth through eighth grade students had recently been relocated leaving the entire second floor empty. The school is made up of general classrooms, science rooms, a music room, library, computer lab, an art room, cafeteria/auditorium and office space. The BCS is equipped with a combination of casement and hopper windows which are openable throughout the school.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school has a student population of approximately 500 and a staff of approximately 50-60. Tests were taken under normal operating conditions and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirteen of thirty-six areas surveyed, indicating fresh air ventilation concerns in some areas of the school, primarily the modular classroom wings. The general MDPH approach to resolving indoor air quality problems in schools is primarily two-fold: 1) improving ventilation to dilute and remove environmental pollutants and 2) reducing or eliminating exposure opportunities from materials that may be adversely affecting indoor air quality.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 2). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 3) and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. All univents were operable and appeared to be well maintained. Obstructions to airflow, such as items placed in front of univent returns, were seen in a few classrooms (see Picture 4). To function as designed, univents and univent returns must remain free of obstructions.

Mechanical exhaust ventilation is provided by wall-mounted intake grilles connected to ductwork. As with the univents, a number of exhaust vents were obstructed by computer carts and other items (see Picture 5). The location of some exhaust vents can also limit exhaust efficiency when the classroom hallway door is open (see Picture 6). When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of an operating exhaust vent to remove common environmental pollutants from classrooms.

Ventilation in the modular classroom wings is provided by rooftop air handling units (AHUs) (see Picture 7). Fresh air is distributed to classrooms via ductwork connected to ceiling-mounted air diffusers. The amount of fresh air drawn into the units is controlled by moveable louvers connected to an activator motor that adjusts to alter fresh air intake to maintain temperature. Return vents draw air back to the units through wall or ceiling-mounted grilles. Thermostats control each heating, ventilating and air conditioning (HVAC) system (see Pictures 8 & 9). In modular classrooms, thermostats have settings of "on" and "automatic". Thermostats were set to the "automatic" setting in most of the modular rooms surveyed during the assessment. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once a preset temperature is measured by the thermostat, the HVAC system is deactivated. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system. Without dilution and removal by the mechanical ventilation system, normally occurring environmental pollutants can build up and lead to indoor air quality and comfort complaints.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. Balancing of these systems is reportedly on-going and is conducted by an HVAC engineering firm hired by the BSD. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself at levels measured in this building. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 64 ^{0}F to 77 ^{0}F, which were below BEHA's recommended comfort guidelines in some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{0}F to 78 ^{0}F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Temperature complaints were reported in classroom 13. BEHA staff, along with Mr. Rose, compared the temperature of the thermostat mounted on the wall in the file room (65^o F) with BEHA analytical equipment (77^o F) and found a temperature discrepancy of +12^o F, indicating a calibration problem with the thermostat. Mr. Rose reported that he would contact the BSD's heating and ventilation contractor to investigate and correct the problem.

The relative humidity measurements in the building were below the BEHA recommended comfort range in the majority of areas sampled. Relative humidity measurements ranged from 21 to 48 percent. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity readings in the 1998 modular wing were 7 to 12 percent higher than the relative humidity measured outdoors (36%) on the day of the assessment. This increase in relative humidity can indicate that the exhaust system alone is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration). Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperature rises, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few rooms had water-stained ceiling tiles, which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles should be replaced after a water leak is discovered. No active roof leaks were reported to or observed by BEHA staff during the assessment. BSD officials report that a preventative maintenance plan has been implemented to remediate occasional leaks in a timely manner by a roofing contractor.

In classroom 20, spaces between the sink countertop and backsplash were noted (see Picture 10). Improper drainage/overflow can lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly it can provide a medium for microbial growth. In a number of classrooms, paper products, board games and other porous items were found stored underneath sinks. If these items become wet repeatedly they can also provide a medium for mold growth. These items should be relocated to a warm, dry environment.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Accumulated chalk dust was noted in several classrooms (see Picture 11). Chalk dust is a fine particulate, which can become easily aerosolized and serve as a source of eye and respiratory irritation. A number of classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999).

Cleaning products were found on counter-tops and beneath sinks in a number of classrooms. Pesticides and artificial snow were found beneath the sink in classroom 9. Artificial snow used to frost windows can contain perchloroethylene. This product should be used only with proper exhaust ventilation and generally not with children in close proximity. Insecticides, cleaning products and other flammable materials contain VOCs, which can cause eye, throat and respiratory irritation.

Under current Massachusetts law effective November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in schools (Mass Act, 2000). In addition, applicators of pesticides should be in full compliance with federal and state rules and regulations that govern pesticide use, including posting and notification requirements (333 CMR 13.10). Under no circumstances should pest-controlling products be applied by untrained personnel. Such products should not be applied prior to or during school hours. If application must be done during the school week, they should be applied shortly after the school day ends, in order to give the applied areas ample time to dry.

Classroom 5 contained a window-mounted air conditioner. This equipment is normally equipped with filters, which should be cleaned or changed as per the manufacturer’s instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter.

A number of return vents in modular classrooms were noted with accumulated dust (see Picture 12). If the HVAC system is not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving, and carpets) in occupied areas and subsequently be re-aerosolized.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made to improve general indoor air quality:

1. Continue to operate supply and exhaust ventilation continuously during periods of school occupancy to maximize air exchange. Operate AHUs for modular classrooms with thermostats in the fan "on" position to provide constant airflow. Contact an HVAC engineering firm to increase the percentage of fresh air intake if necessary.
2. Continue with plans to conduct renovations. Roof replacement and upgrading HVAC equipment should further improve indoor air quality.
3. Consider having the systems balanced by an HVAC engineering firm every five years as per industry standards (SMACNA, 1994).
4. Remove all obstructions from univents and mechanical exhaust vents to facilitate airflow.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Once roof repairs are complete, replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
7. Seal areas around sink in classroom 20 to prevent water-damage to interior of cabinets and adjacent wallboard.
8. Do not store paper products or other cellulose-containing materials beneath sinks. To prevent water damage to these materials, remove them from beneath sink and store in a dry area.
9. Store cleaning products and chemicals properly and keep out of reach of students. Consider discontinuing the use of artificial snow. Remove pesticides from classrooms.
10. Clean chalkboards and trays regularly to prevent the build-up of excessive chalk dust.
11. Clean return/exhaust vents periodically to prevent the accumulation of dirt and dust.
12. Change filters in window mounted air conditioners as per the manufacturer's instructions, or more frequently if needed.
13. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

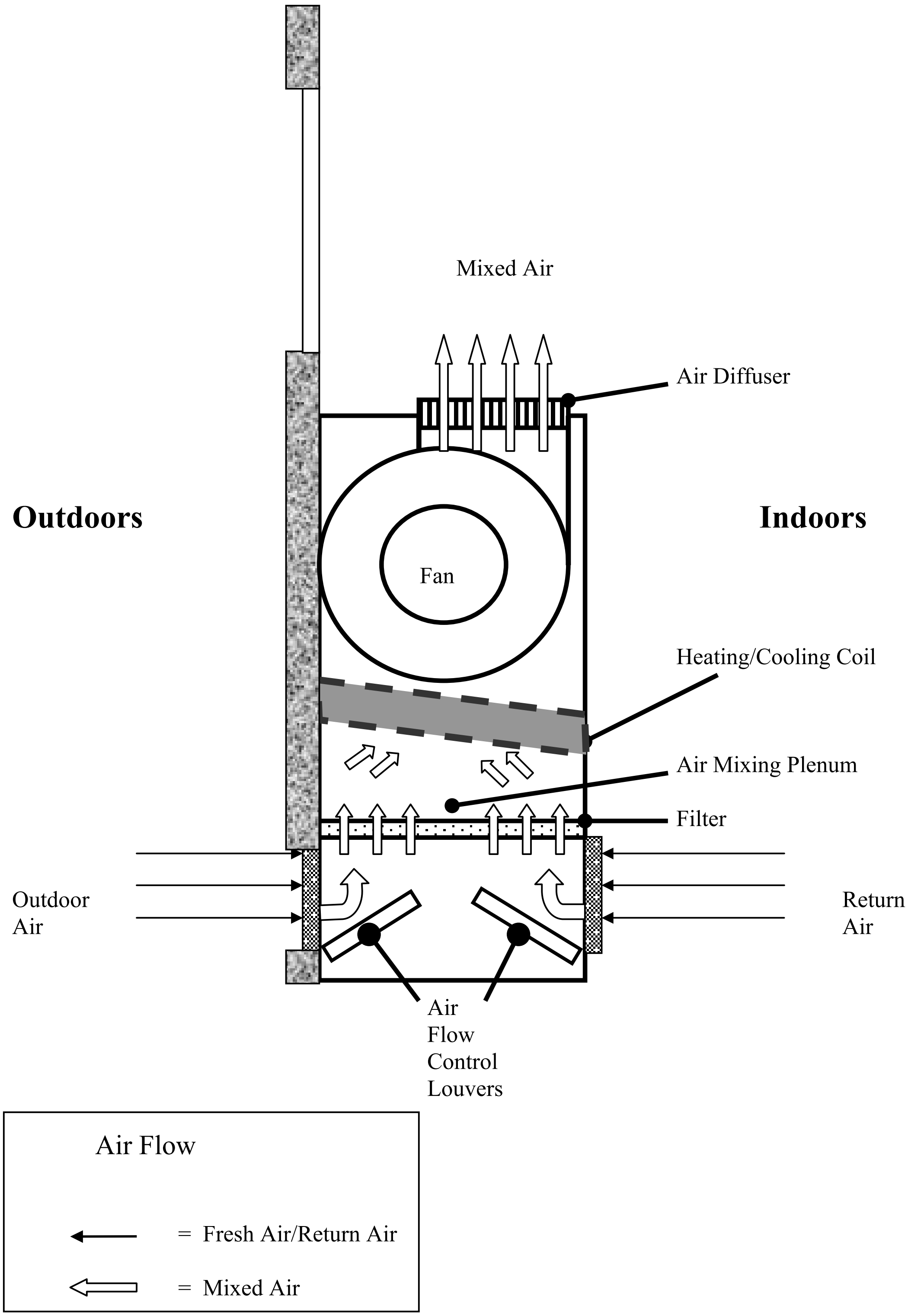
OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Figure 1 **Unit Ventilator (Univent)**



Picture 1

1996 & 1998 Modular Classroom Wings

Picture 2

Classroom Univent

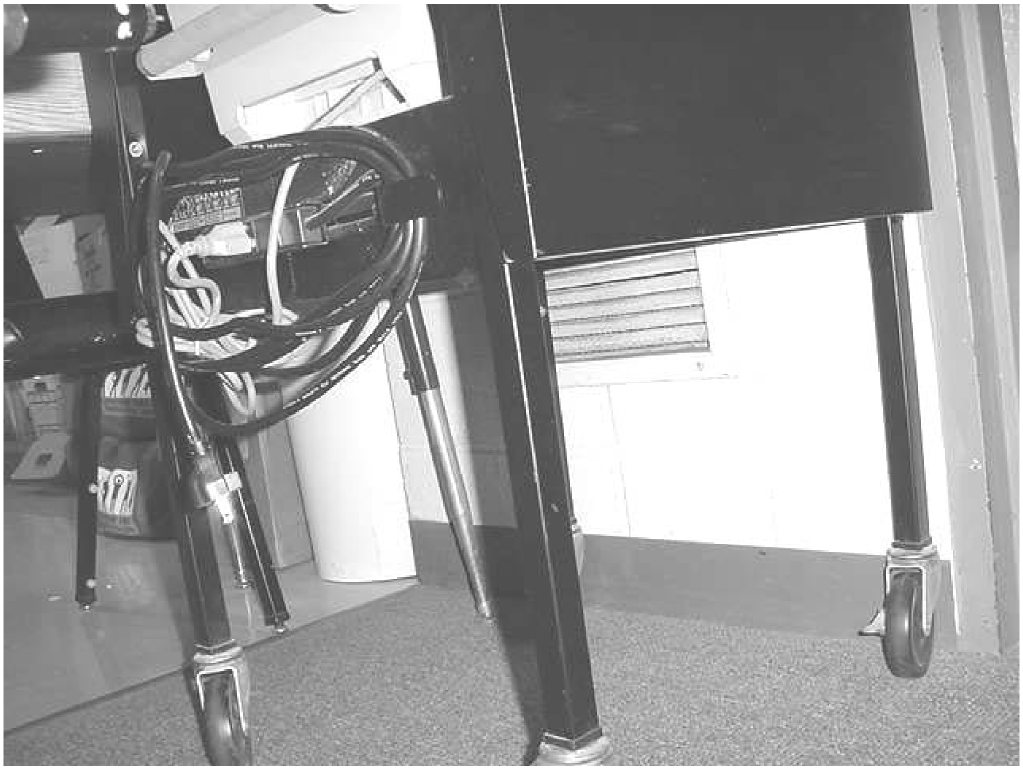
Picture 3

Univent Fresh Air Intake on Exterior of Building

Picture 4

Univent Airflow Obstructed by Various Items

Picture 5



Wall-Mounted Exhaust Vent Partially Obstructed by Computer Cart

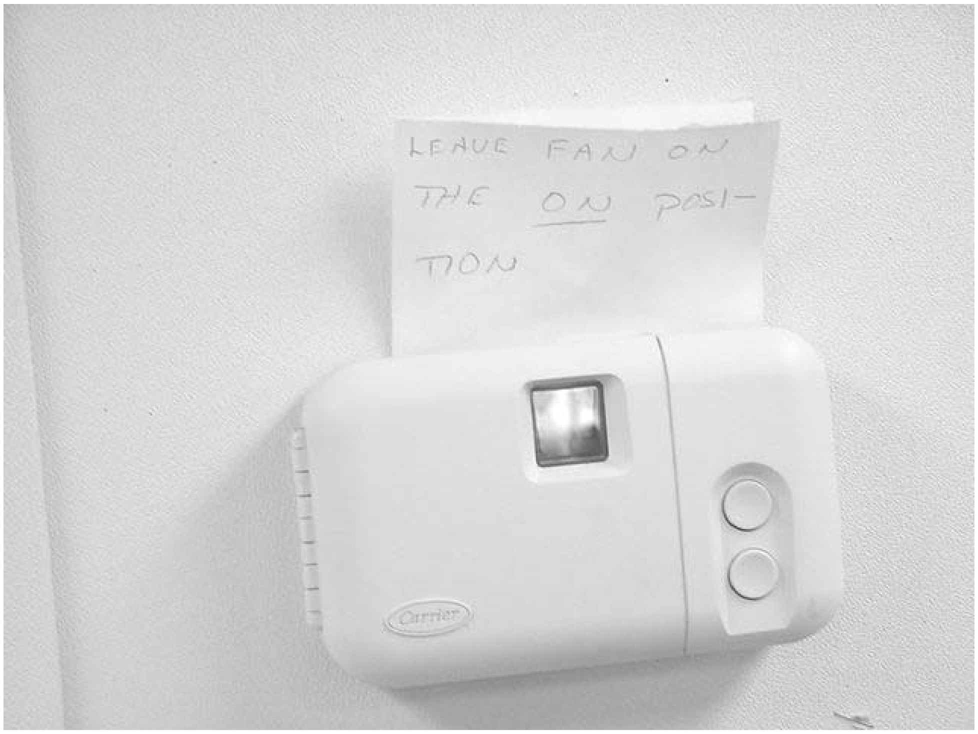
Picture 6

Classroom Exhaust Vent, Note open Hallway Door

Picture 7

Rooftop-Mounted AHU for Modular Classroom

Picture 8

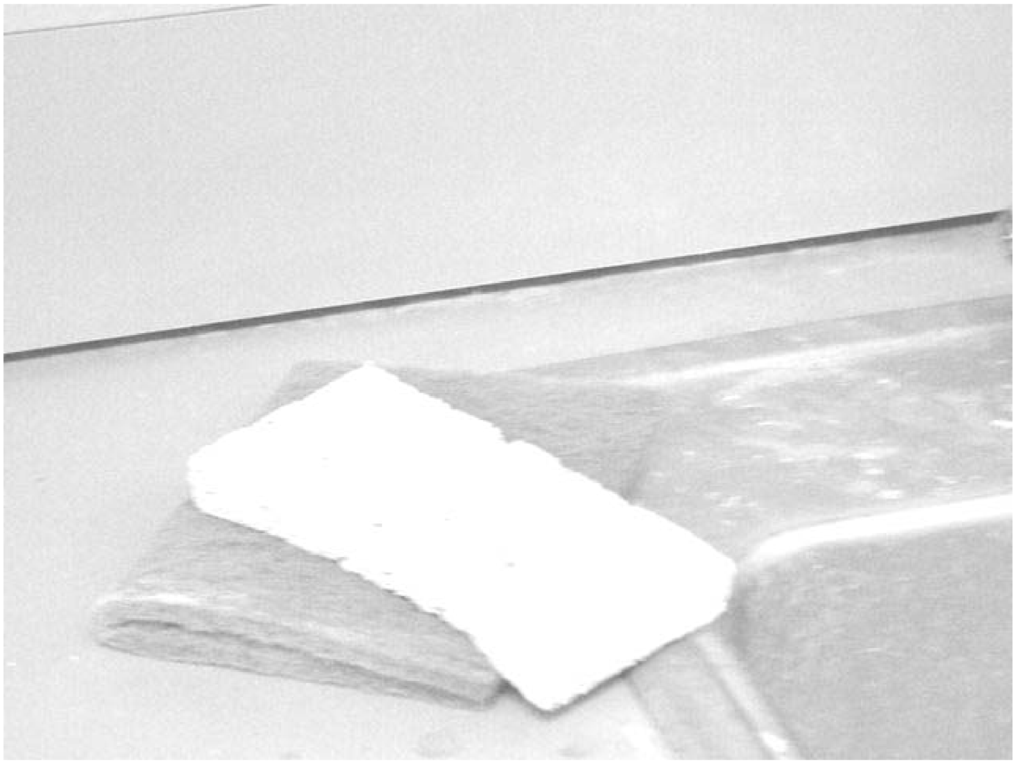


Modular Classroom Thermostat

Picture 9

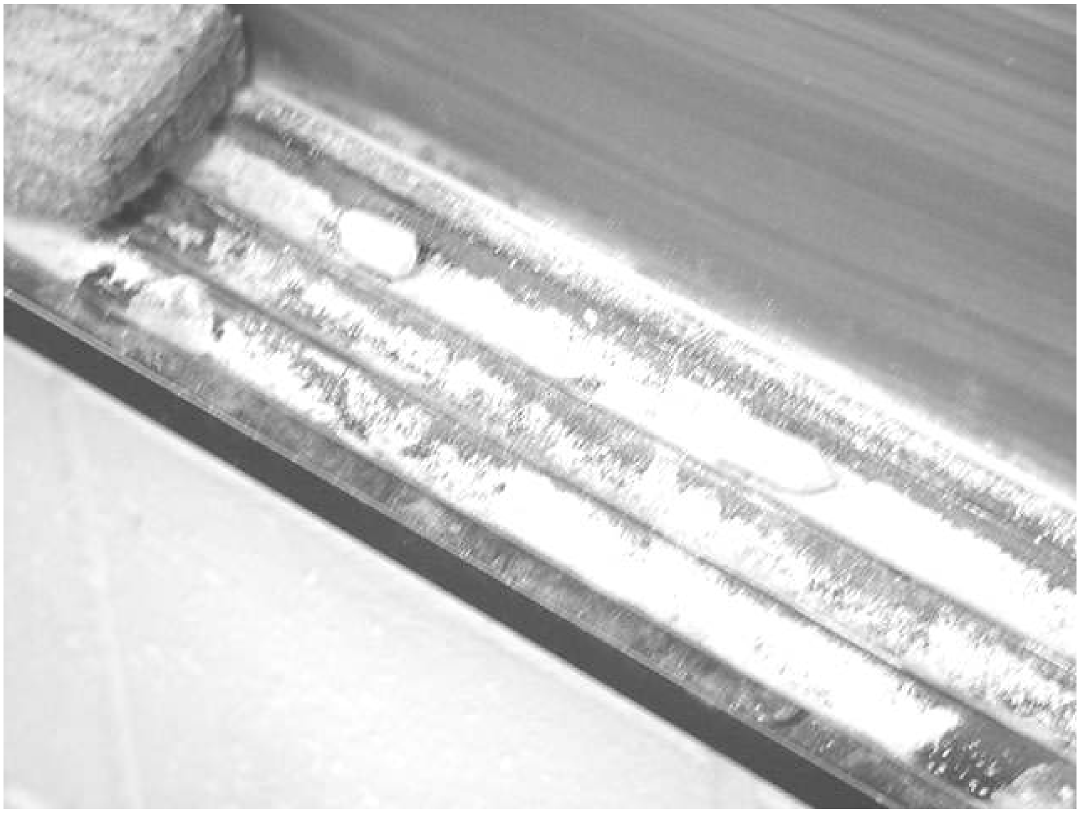
Modular Classroom Thermostat Note Fan Switch to Auto Position

Picture 10



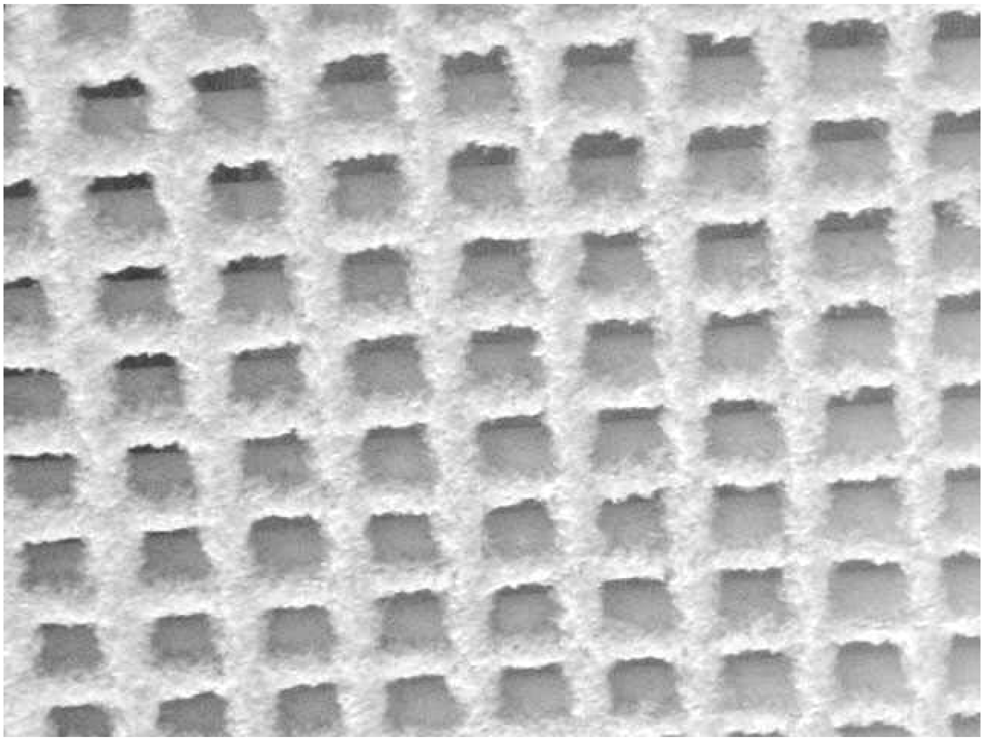
Space between Sink Countertop and Backsplash

Picture 11



Accumulated Chalk Dust in Classroom

Picture 12



Accumulated Dust on Modular Classroom Return Vent

TABLE 1

Indoor Air Test Results – Berkley Community School, Berkley, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	360	43	36					Weather conditions: cloudy, cold
Gym	482	71	21	20+ no	Yes	Yes		
Room 16	780	73	23	25	Yes	Yes	Yes	Cleaning products under sink, chalk dust
Room 17	730	74	23	18	Yes	Yes	Yes	Cleaning product on counter
Room 18	528	73	21	~15	Yes	Yes	Yes	Door open
Room 14	710	75	23	20	Yes	Yes	Yes	Chalk dust, games/cardboard under sink, door open
Room 13	530	77	22	26	Yes	Yes	Yes	Window open, thermostat problem (set for 65º F/temperature 77º F) – director of bldgs/grounds notified- "will address"
Room 20	422	74	20	0	Yes	Yes	Yes	Chalk dust, backsplash
Room 21	365	72	20	1	Yes	Yes	Yes	
Room 1B	705	71	24	5	Yes	Yes	Yes	Dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Berkley Community School, Berkley, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 1A	1120	71	26	23	Yes	Yes	Yes	
Room 42	1564	70	32	20	Yes	Yes	Yes	Thermostat-fan "on", door open
Step Classroom	1386	71	33	8	Yes	Yes	Yes	Thermostat-fan "auto", ventilation off, dust accumulation on return vents
Room 45	1471	70	31	20	Yes	Yes	Yes	Fan-"auto", door open
Room 51	1700	64	48	2	Yes	Yes	Yes	Fan-"auto", 8 occupants gone 45 mins.
Speech & Language	990	67	40	1	Yes	Yes	Yes	Fan-"auto", door open
Room 52	1491	68	42	13	Yes	Yes	Yes	Fan-"auto", door open, 1 water-damaged CT
Room 55	1539	69	42	8	Yes	Yes	Yes	Fan-"auto", door open
Room 12	707	73	23	26	Yes	Yes	Yes	Chalk dust, exhaust blocked by cart, door open
Room 11	640	74	22	24	Yes	Yes	Yes	

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TABLE 3

Indoor Air Test Results – Berkley Community School, Berkley, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 10	591	74	23	23	Yes	Yes	Yes	Window and door open, exhaust partially blocked, plant
Room 9	629	73	23	22	Yes	Yes	Yes	Door open, insecticides/cleaning products/spray snow under sink, exhaust vent blocked by computer caddy
Cafeteria	635	73	24	>100	Yes	Yes	Yes	Rooftop unit, wall exhaust
Teacher's Lunch Room	610	73	23	9	Yes	Yes	Yes	Air conditioner, door open
North Side-Boy's Restroom				1	Yes	Yes	Yes	Passive
Custodian							Yes	
Room 54	1609	69	42	9	Yes	Yes	Yes	Fan - "auto", 3 water damaged CT
Room 53	2360	70	41	16	Yes	Yes	Yes	Fan – "auto", accumulated items
Room 8	740	69	34	19	Yes	Yes	Yes	
Room 3	1377	71	35	12	Yes	Yes	Yes	Door open

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TABLE 4

Indoor Air Test Results – Berkley Community School, Berkley, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 7	940	73	30	0	Yes	Yes	Yes	Door open, chalk dust
Room 4	781	72	28	18	Yes	Yes	Yes	Return vent blocked
Room 6	895	73	27	19	Yes	Yes	Yes	Door open
Room 5	769	73	27	19	Yes	Yes	Yes	Window mounted air-conditioner, dry erase board
North Learning Lab	446	77	24					
S-CH (1st grade)	457	76	20	1	Yes	Yes	Yes	
Musician	584	73	18	1	No	Yes	No	2 water damaged CT, no exhaust identified
Art Room	578	74	22	23	Yes	Yes	No	1 water damaged CT, no exhaust identified
Room 23	418	72	23	0	Yes	Yes	Yes	

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